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The "Bedrock Lands" of Sacramento County.

The high quality of the fruit produced in the foothill lands of the Sierra is well recognized, and as time progresses a large proportion of these lands will undoubtedly be given to orchards and vineyards. The border lands of the great valley lying along their foot, that have thus far been mostly devoted to wheat-growing, are likely to share the same fate, provided the expansion of the market for California fruits, now forming the subject of much anxiety and discussion, shall justify a corresponding enlargement of the area of fruit culture. The soil of these border lands varies from a grayish loam of alluvial character, occupying the lower ground, to a yellow or reddish soil which usually forms low broad ridges running from the foothills proper into the valley; the intensity of the tint increasing as the hills are approached, where the prevailing color is the proverbial "red" of the placer mines.

On the foothills from Butte south to Amador the adaptation of the soil to fruit and vine culture seems to be little more than a question of depth above the bedrock; although in numerous cases the latter is itself so soft that the roots of the hardier kinds, such as the vine, fig, olive and carob, can without difficulty make their way into, and draw both moisture and sustenance from it. In the rolling border lands of the valley the soil, or rather subsoil, is usually of sufficient depth and penetrability for all purposes; but to this rule there are exceptions, in the local occurrence of tracts ranging from a few acres upwards, where an apparently impenetrable material underlies at depths varying from one to several feet; and although this material is altogether different from the slates underlying the foothill lands, the fact that it produces the same effect on the welfare of fruit trees has caused the local name of "bedrock lands" to be given to such tracts.

An able article, giving an account of the region in question, appeared in the Sacramento *Bee* in May last, and a few weeks afterwards a set of representative samples of soil, subsoil and "bedrock" with underlying strata, carefully taken according to directions, was furnished by Mr. Wm. A. Lawson, of the staff of the *Bee*, with the inquiry whether the lower layers would, if broken, contribute anything to the nutrition of trees. These samples were from the neighborhood of Florin, Sacramento county, from which region a sample of surface soil had been previously sent by Mr. James Rutter, of Florin. About a month later, a corresponding set of samples were received from Mr. D. Lubin, of Sacramento, showing the state of things on some portions of Weinstock & Lubin's ranch near Mayhew Station, on the Sacramento Valley Railroad. Although derived from localities several miles apart, the two sets agree very closely, and show the following arrangement of layers:

1. Pale orange surface loam, four to forty-eight inches thick.
2. Stiff brownish abobe, three to twelve inches thick.
3. Brown or whitish hardpan, one to ten feet thick.
4. Brown or white coarse sand, depth not known.

No. 1, the loam forming the soil and ordinarily the subsoil of the region is apparently identical in the two localities, and is scarcely distinguishable from the soils prevailing, *e. g.*, near Wheatland, Yuba county, in a corresponding position; it also agrees very nearly in the essentials of chemical composition.

The brown adobe, No. 2, which forms an almost uniform layer over the bedrock everywhere, has evidently been formed out of the latter in the course of time by the usual process of soil-formation and, as will be seen below, the two scarcely differ in composition more than might different portions of either, from each other.

The "bedrock" hardpan, No. 3, differs somewhat in aspect in the two localities. At Mayhew Station it is a yellowish-white, almost chalky, uniform mass, covered on top by a blackish, smooth, almost shiny crust an eighth of an inch thick, manifestly formed by the deposition of brown iron ore (limonite); it would, alone, effectually prevent the penetration of roots into the hardpan. The latter is quite compact and free from grit above, but downward gradually becomes more friable and sandy, and finally seems to pass into almost pure, sharp sand, at times of a strong rusty tint, but mostly white. Mr. Lubin states that this rock crumbles on exposure to the air.

At Florin the "bedrock" is less compact, of a rusty tint, and instead of the hard, shining crust on the surface, it is penetrated in all directions by blackish streaks of the iron ore. It seems more nearly ready to form the adobe than the material at Mayhew, and is more readily penetrated by roots, but in general character is very nearly alike.

These differences account for some differences in the experience had in this bedrock land in

regard to the success of orchard trees planted on it. It is stated that they flourish for a few years, varying with the depth of the soil, but about the time that the roots reach and would need to penetrate the hardpan layer, they cease growing and often finally die. The question arises whether this is due simply to the impenetrability of the "bedrock," which prevents the roots from gaining access to a sufficient supply of moisture and plant food; or whether any injurious ingredients, or other conditions, play a part in the failure of the trees.

The analysis of the samples from Florin of the three successive layers—the surface loam,* adobe and hardpan or "bedrock," gave the following results:

	No. 1. Soil.	No. 2. Adobe Subsoil.	No. 3. Bedrock. Hardpan
Coarse material	4 8	.....	.....
Fine earth	95.2	.....	.....
CHEMICAL ANALYSIS.			
Insoluble matter	82.936	72.071	72.652
Soluble silica	6.277	7.507	6.118
Potash	.278	.378	.427
Soda	.073	.163	.143
Lime	.599	.522	.614
Magnesia	.226	.640	.947
Br. oxide of manganese	.089	.020	.019
Peroxide of iron	1.908	5.100	5.645
Alumina	5.419	9.440	9.311
Phosphoric acid	.019	.045	.081
Sulphuric acid	.011	.014	.011
Water and organic matter	2.262	4.123	4 083
	100.097	100.023	100.051
Humus	.461	.....	.....
Available phosphoric acid.	.016	.....	.....
Hygroscop. moisture	2.66	7.655%	8.738%
Absorbed at	14° C.	.....	.....

* Sample sent by Mr. Jas. Rutter.

It is curious to note in the above analyses, that, notwithstanding the great differences in the appearance of the three materials, they do not differ widely in most points of their composition. The prominent points of difference are that the surface soil contains about 10 per cent more of inert matter (fine sand) than the other two, but much less iron, and only a very minute amount of phosphoric acid. The latter, however, increases very rapidly downward, the adobe containing more than twice as much as the top soil, and the "bedrock" again nearly twice as much as the adobe, or four times as much as the surface soil. The deficiency of the phosphoric acid in the soil is measurably offset by the fact that nearly all of it (.016 out of .019), is in an available condition, and hence the deficiency has not been much felt in the past; yet it does seem quite important that the relatively large supply in the lower depths should, if possible, be rendered accessible to the roots of trees. The supply of lime is nearly the same in all, and probably adequate, although more would be desirable in the stiff adobe.

It is certain that this desirable downward penetration of tree roots is not possible, when, as near Mayhew Station, they encounter a hard, polished crust covering a very solid hardpan of several feet depth; and while at Florin the hard crust is less prominent and the material less solid, yet its condition indicates a want of drainage during the wet season, causing the formation of iron solutions, injurious to the root tips, exactly as in the other locality. It is obvious that the roots cannot go far during the season through such a substratum; and the breaking up of the latter by some financially practicable method would seem to be the necessary condition for the success of orchards.

Messrs. Weinstock & Lubin have attempted this on a somewhat extensive scale on their ranch near Mayhew. Mr. Lubin describes the process as follows: "A hole 5 x 6 feet and six feet deep was dug for each tree. It is necessary to blast the bedrock layer with giant powder; even when using from three to five sticks much picking has to be done, in order to shatter thoroughly the several sedimentary layers. The work thus done is quite thorough but very costly, ranging from $65 to $75 per acre. Messrs. Kroll and Rutter simply drill a hole with auger, put in a charge of black powder which blasts a little rock, and then plant their trees. Query—Will this be sufficient in the long run? It would cost only about $30 per acre, and would be cheap at that if the land could thus be made to grow Bartlett pears and the like."

It certainly seems very desirable to avoid the heavy expense of digging through the "bedrock;" and if it can be sufficiently shattered by blasting at the bottom of a bore-hole, all that is really needful will have been accomplished. A charge of common black powder is not likely to do this; while on the other hand, so high an explosive as dynamite would not be sufficiently extensive in its pulverizing action, as is shown by the use of so many cartridges in one hole by Mr. Lubin. I therefore suggested the use of "Judson powder" in a bore hole of sufficient depth, and the subsequent digging of the holes to the usual depth only.

In a late communication Mr. Lubin states that Judson powder does not do sufficient execution in the "bedrock," and that giant powder No. 2 seems preferable. The kind of explosive to be used with the greatest advantage will naturally vary from place to place, with the nature of the hardpan, and will have to be ascertained by trial—which could best be made before the rains set in. But in view of the fact that the substratum of the "bedrock lands" is shown to be actually richer in plant food than the surface soil; that while in its natural condition it not only obstructs the passage of the roots mechanically, but also injures them by

the formation of poisonous solutions in consequence of the stagnation of water; all of which can be relieved by the shattering of the substratum by means of judicious blasting, also giving the roots access to abundant moisture: It would certainly seem that in favorable locations, where land is valuable, this mode of rendering it available for fruit culture deserves most earnest consideration. Neither the adobe nor the "bed-rock" should be used in the filling up of holes after planting, any more than a raw subsoil should be turned on the surface in other cases. But with the access of air and water to the shattered portion, the substrata will gradually go through the processes of soil formation; and their plant food will doubtless become available fast enough to insure the welfare and productiveness of an orchard for the usual period.

E. W. HILGARD.

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